ATLAS Scintillating Tile Calorimeter

Mechanical Assembly Quality Assurance Plan

VERSION 1.0

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OVERVIEW

ATLAS is one of two general purpose detectors being constructed for the study of proton-proton collisions at the CERN Large Hadron Collider (LHC).The scintillating tile calorimeter (TileCal) design and construction is the responsibility of a large international collaboration within the ATLAS collaboration as a whole. The calorimeter concept is described in detail in the ATLAS Technical Proposal (CERN/LHC/94-43) and in the Tile Calorimeter Technical Design Report (CERN/LHCC/96-42). Scintillators are mounted radially to the beam direction in slots between steel absorber plates and are read out using edge-coupled wavelength shifting fibers and photomultiplier tubes. The absorber structure is a composite of glued steel plates in which shorter plates (spacers) are sandwiched between longer plates (masters) to form the slots in which the scintillator tiles are placed. The instrumented modules are assembled into a self-supporting structure in the underground cavern. In addition to our technical responsibilities, Argonne acts as a nucleus for the groups participating in the Tile Calorimeter subsystem from the United States, which currently comprise the University of Chicago, the University of Illinois, Michigan State University and the University of Texas at Arlington.

The detailed specification of Argonne's agreed obligation to the ATLAS detector system is covered in a Memorandum of Understanding between Argonne National Laboratory and the US ATLAS Collaboration Project Management at Brookhaven National Laboratory dated (Appendix I), and subsequent annual amendments. Briefly the scope of work comprises :

1. mechanical design and engineering of the structure, the calorimeter assembly and construction tooling

2. materials procurement

3. component fabrication (masters, support girders)

4. construction of 192 submodules

5. construction of 64 extended barrel modules each containing 1 special submodule, 1 ITC submodule and 8 standard submodules

6. shipping of 32 modules to Michigan State University for instrumentation

7. shipping of 64 instrumented and tested modules to CERN, Geneva, Switzerland

8. calorimeter pre-assembly and final assembly in the underground cavern at CERN

The two principal mechanical construction tasks are submodule construction and module construction. These tasks are carried out in Building 366.

A submodule weighs approximately one ton and is constructed in about a day of technician effort using a crew of two technicians supplemented by some welder effort. The construction operation is quite straightforward:

master and spacer plates are first cleaned and given a roughened surface by passing them through a commercial plate cleaning machine (Timesaver™)

glue is applied to the plates using a custom design semi-automated glue machine

plates are placed periodically on a custom stacking table and compressed to height

following curing of the glue four straps are tack-welded onto the corners of the partially completed submodule and it is lifted from the stacking table onto a machine table where final (full) welding of the straps is completed

any glue which has squeezed out is then removed and the submodule measured following a series of defined locations and protocols

the submodule is painted in a custom paint system, wrapped and moved to a storage area

A module weighs about 10 tons and is constructed in about one week using a crew of one technician and an engineer supplemented by some rigging effort. Again the construction operation is quite straightforward:

1. the main support girder is mounted and aligned on the assembly base

2. submodules are sequentially taken from storage and mounted on the support girder

3. the submodules are aligned using an optical transit and internal reference system then bolted to the girder following a prescribed procedure

4. following mounting of the 10 submodules in total an exterior plate is mounted and a simple plate welded in at the inner radius of the structure

5. a straightforward check of the module envelope and is completed following a defined procedure

6. the completed module is then removed from the assembly base and either placed in the instrumentation area at Argonne or mounted of shipping beams and shipped to Michigan State University.

The construction of the calorimeter absorber structure is to be completed module in the period from Jan 4, 1999 to Jan 3, 2002.

As can be seen from the above scope of work, the work being carried out for the construction of the TileCal calorimeter is quite typical of the sort of mechanical work which has been carried out in the High Energy Physics Division over the last two decades. The Division Quality Assurance Plan is therefore the primary basis for the ATLAS QA Plan. A copy of the Division Quality Assurance Plan may be obtained from the Hep Division Office. We discuss the specifics of the ATLAS TileCal QA Program in detail below.

PROGRAM

The co-Principal Investigators for the Tile Calorimeter construction are L. Price and J. Proudfoot.

The lead physicist and engineer for the mechanical assembly task are J. Proudfoot and V. Guarino respectively. An Engineering Associate (L. Kocenko) oversees all submodule construction activities on a day to day basis. Regular weekly meetings of these three persons and the Building Manager for Building 366 are held to review work activities, address construction issues and priorities and to set the work program for the week. This meeting also serves as a forum at which any work related problem may be raised. The US-ATLAS TileCal subsystem Leader is L. Price who chairs a weekly telephone conference meeting of the US groups participating in the construction of the detector system. The participants are the subsystem leaders at each location (UC, UI, UTA and MSU) plus other physicist and engineers as the need arises. Technical, administrative and financial issues are addressed at this meeting.

PERSONNEL QUALIFICATION & TRAINING

The assembly work being carried out in general does not require skills beyond those expected of members of the mechanical support group and general training for technicians in Building 366 (specifically machine tools, forklift, lifting and rigging, building safety and others as covered by the guidance in the Division QA Plan). A training procedure has been established for the one special purpose machine (Timesaver) and a record of trained technicians is maintained.

Other training is carried out as needed in accordance with the Division QA Plan.

QUALITY IMPROVEMENT

ATLAS/TileCal follows the Division Plan regarding this criterion. Open communication is supported and encouraged at all levels; the weekly production meeting provides a more formal forum at which issues and concerns may be raised. Monthly reports document work activities. A web-based system tracks performance issues at all submodule and module construction site both here in the US and in Europe. This allows a coherent comparison of work in all locations under a single QC Manager for the Tile Calorimeter Collaboration as a whole.

DOCUMENTS

Follow Division Plan

WORK PROCESSES

The Division Plan which is the basis for all TileCal mechanical assembly work.

Careful attention has been paid to the control of work processes specific to ATLAS TileCal mechanical construction both here in the US and in Europe. A list of the current controls available to the technical staff and physicist involved in the project is given in Appendix II. Of these, several are of significant importance and specific to submodule assembly work:

Scheduled Maintenance for Atlas production Equipment

Checklist for Submodule Construction

Assembly Checklist for the Atlas submodule construction

Checklist for Submodule Stacking

Rigging and Hoisting Procedures for Atlas Submodule Production

These are included in Appendix III.

Welding of the corner straps is central to the structural integrity of the assembled calorimeter. A Weld Process Specification (WPS) has been developed as a means of ensuring that these welds are executed correctly (Appendix IV).

CALIBRATION

The Division Plan is the basis of all ATLAS TileCal mechanical assembly work.

One custom calibrated device is specific for the Tile calorimeter and this is a gauge bar use to ensure the commonality and the dimension of the key-ways at each end of a submodule. A single custom gauge is used throughout the Tile Calorimeter Subsystem to ensure that the stacking

fixture in use at each of the 9 construction sites meets the dimensional goals of the detector. This gauge was measured and certified on a CMM machine at CERN. It is circulated around the collaboration on a frequency of 6 months and results recorded in a web-based document.

DESIGN CRITERIA

Follow the Division QA Plan.

A detailed description of the calorimeter at the time of technical review and approval for proceeding toward construction can be found in the Tile Calorimeter Technical Design Report (CERN/LHCC/96-42). A reference copy of this document is available from the 366 Building Manager.

PROCUREMENT

Follow the Division QA Plan.

INSPECTION & TESTING

The Division QA Plan is adopted for all ATLAS TileCal mechanical assembly work.

Specific areas in which critical requirements were identified include:

1. master plate production (documented in ANL-HEP-TR-99-04)

2. submodule construction, for which internal inspection protocols have been established and are given in Appendix V

3. girder fabrication (the quality control and inspection specifics required in the procurement are given in Appendix VI)

4. module construction, for which internal inspection protocols are being established (present draft protocol is given in Appendix VII)

MANAGEMENT ASSESSMENT

The Division QA Plan is adopted for all ATLAS TileCal mechanical assembly work.

Technical review is conducted by ATLAS Technical Coordination and the US-ATLAS Project Management Office.

INDEPENDENT ASSESSMENT

The Division QA Plan is adopted for all ATLAS TileCal mechanical assembly work.

General peer review of the Group's performance is made by annual reviews organized by the University of Chicago and by the DOE.